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(54) Filter apparatus

(57) The apparatus 2 has an inward flow tubular filter element 16 arranged to be cleaned by back-washing using liquid filtrate from which suspended matter has been removed by passage of the liquid through the filter element. The filter element 16 defines a barrel in which a piston 30 is arranged to reciprocate. During back-washing, reciprocation of the piston 30 forces liquid filtrate outwardly through the filter element 16 to dislodge filtered out contaminant from the exterior thereof. Back-washing may be automatically initiated by a timer or in response to a fall in filtrate pressure below a predetermined amount.

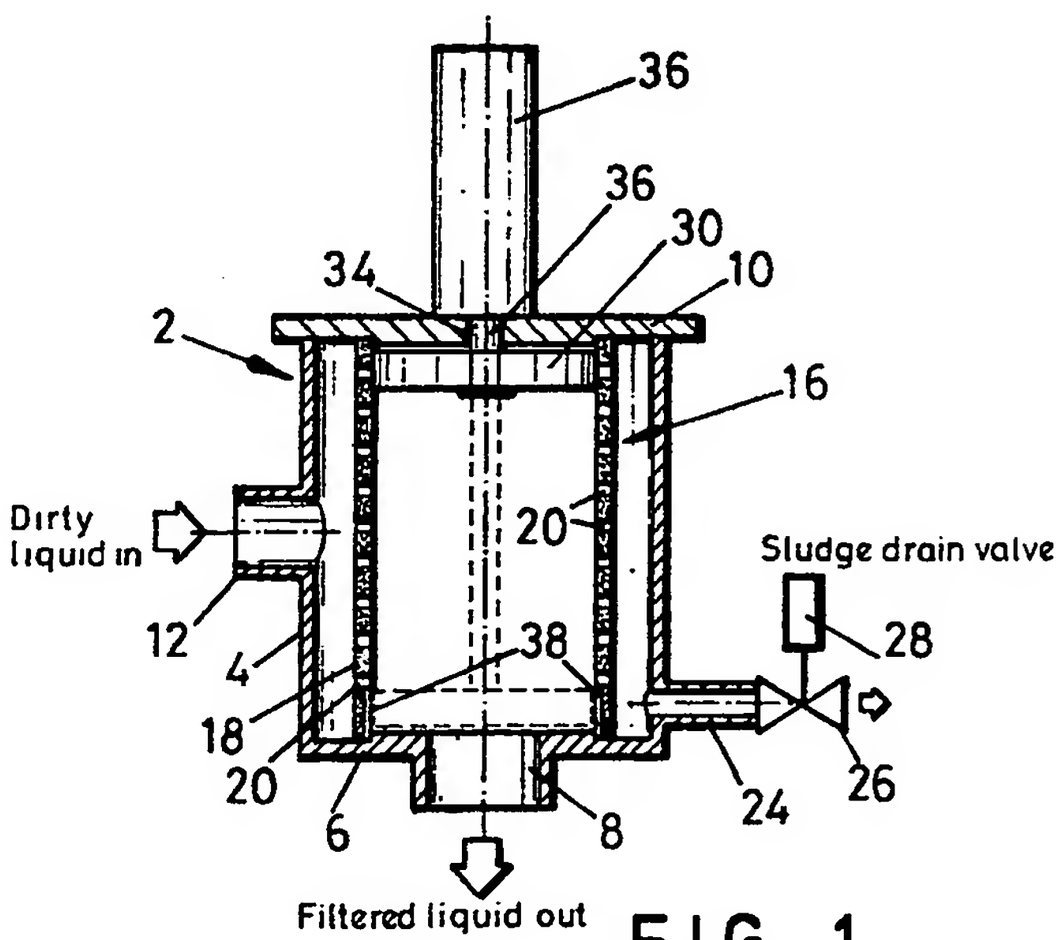

FIG. 1

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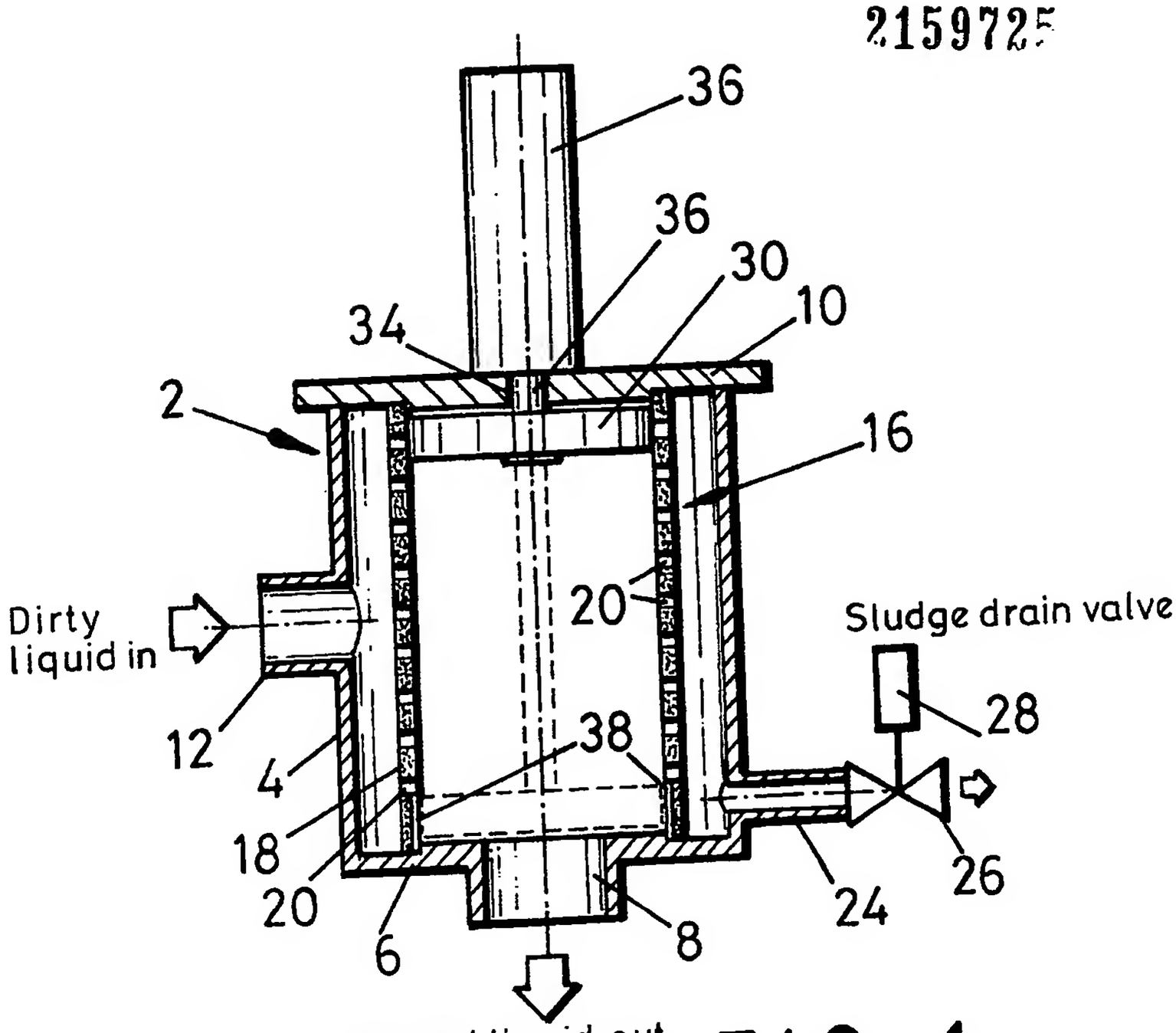


FIG. 1

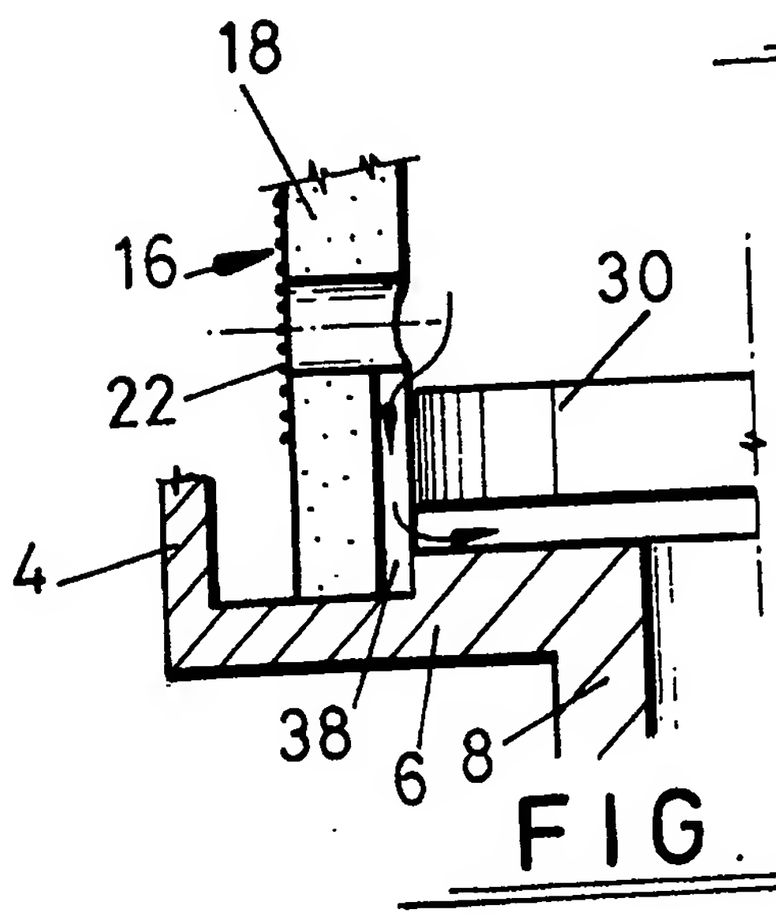


FIG. 2

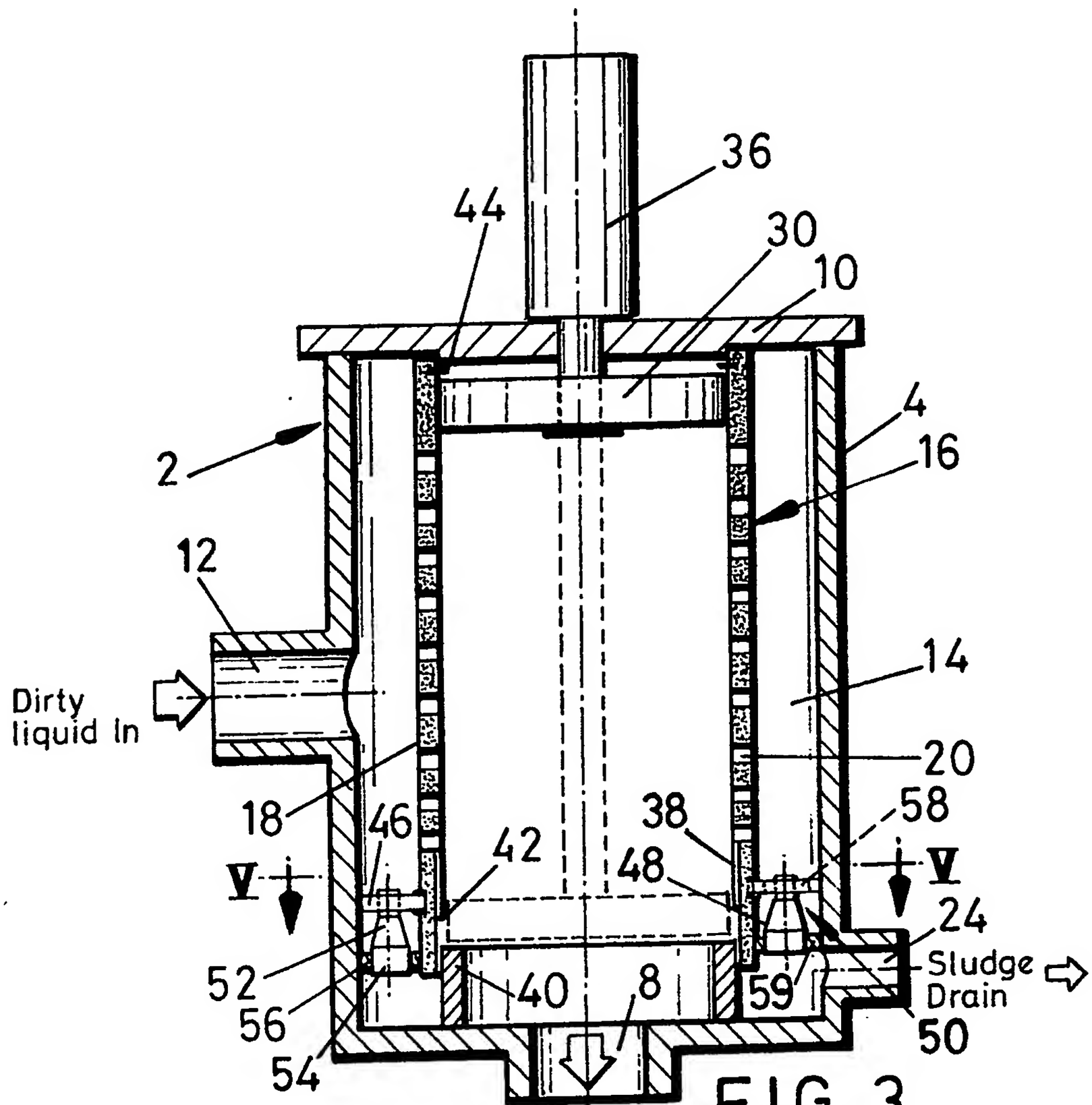


FIG. 3

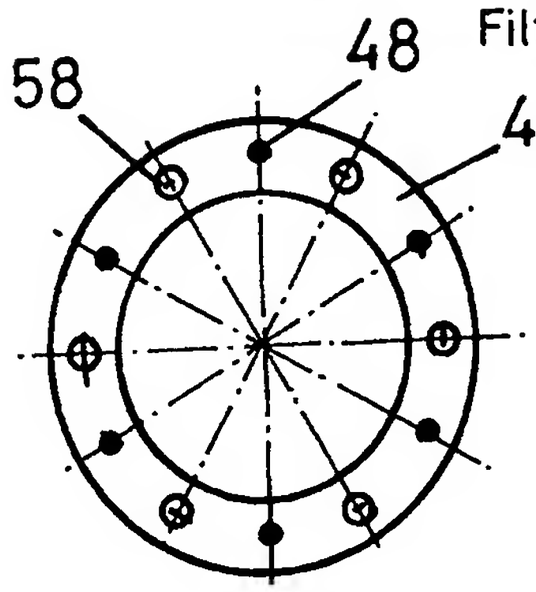


FIG. 5

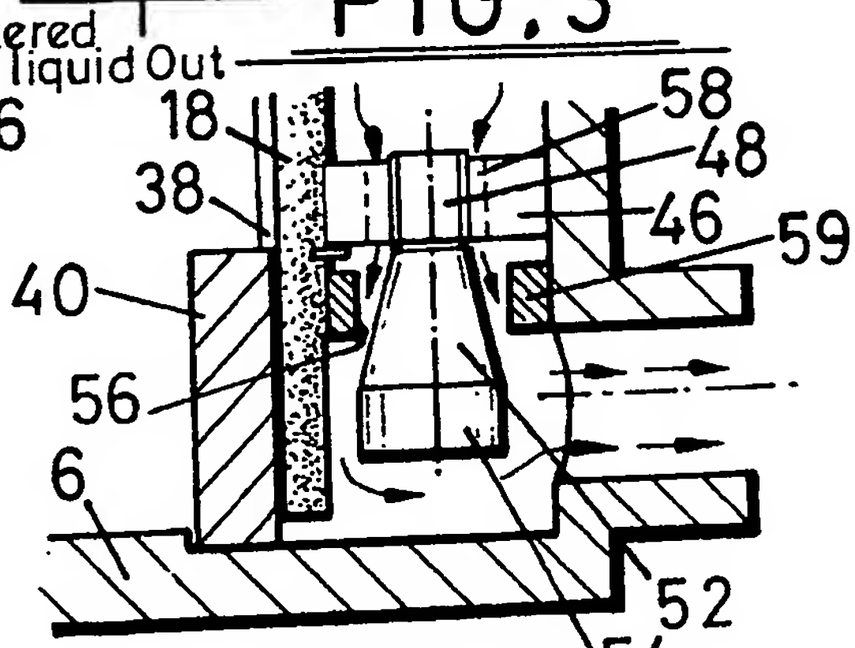
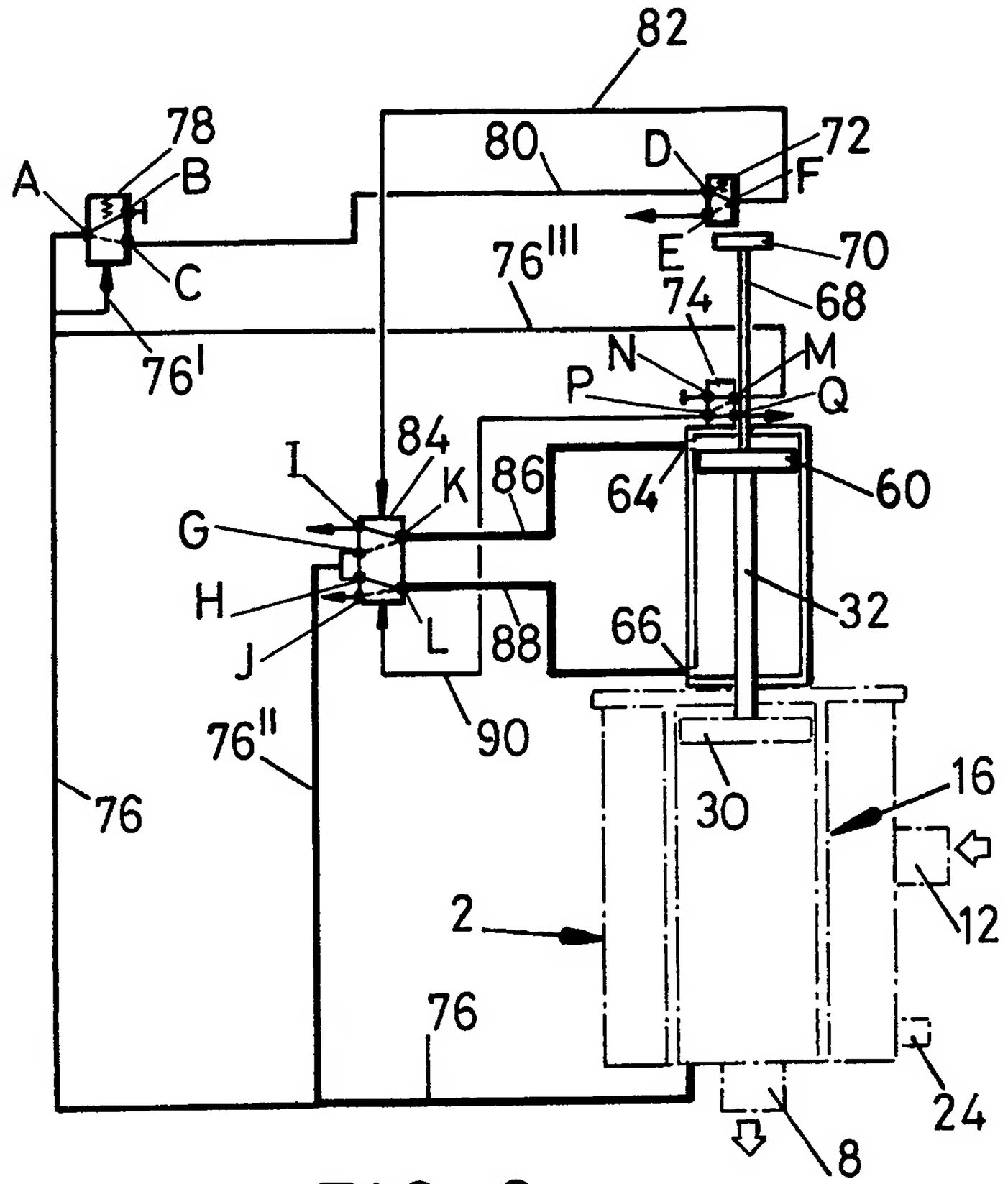


FIG. 4


82
78
80
D
72
A
B
F
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70
76III
74
68
C
76I
N
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Q
84
I
K
86
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60
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32
J
90
76II
76
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16
2
12
76
24
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FIG. 6

SPECIFICATION

Filter apparatus

This invention concerns a filter apparatus of the type (hereinafter called "the type referred to") having a filter element arranged to be cleaned by back-washing using liquid filtrate from which suspended matter (hereafter called contaminant) has been removed by passage of the liquid through the filter element.

An apparatus of the type referred to is known in which the filter element is a stationary hollow drum having a cylindrical wall with passages therethrough through which liquid passes into the interior of the drum to exit therefrom at an end of the drum leaving adhering on the drum exterior contaminant previously suspended in the liquid. On the cylindrical interior of the drum are axial gear teeth meshing with an idling pinion meshing with a driven pinion coaxial with the drum. It is intended that when the driven pinion is rotated it rotates the idling pinion to cause the latter to progress around the drum interior during which the meshing teeth on the idling pinion and drum co-operate in the manner of a gear pump forcing filtrate radially outwards through the drum wall as a back-wash to dislodge the adhered contaminant from the exterior and thus cleanse the filter element. Unfortunately this gearing arrangement requires costly precision engineering in order to attain the necessary fluid-tight seal between the meshing gear teeth so as to obtain a proper pumping effect to give the back-wash sufficient force to dislodge the contaminant. But such closeness of fit between the meshing gear teeth makes the gearing Drone to seizure. On the other hand making the meshing less tight spoils the seal so that there is no pumping action or it is very inefficient and the back-wash is weak giving poor cleansing.

An object of the invention is to provide a filter apparatus of the type referred to which can avoid the aforesaid disadvantages.

According to the invention a filter apparatus of the type referred to comprises a tube shaped filter element, means to introduce liquid containing suspended contaminant to the exterior of the filter element so that liquid filtrate passes through the filter element into the tube interior leaving filtered-out contaminant on the exterior, and said tube forming a barrel in which a piston is arranged to reciprocate axially of the tube so as to force liquid filtrate from the tube interior back through the filter element as back-wash during at least one stroke of the piston for the purpose of dislodging filtered-out contaminant from the exterior of the element.

The piston may be reciprocated one or more times as and when desired. Reciprocation may be performed automatically at pre-determined intervals of time in response to control means including timer means, or may be performed automatically upon detection that the extent of obstruction of the filter element by contaminant is in excess of a pre-determined amount, for example by observing a pressure drop across the wall of the filter element so that when the differential pressure exceeds a predetermined value the piston is reciprocated.

The filter element may be surrounded by a casing between which and the element is a space into which the liquid containing the contaminant is introduced. From a lower part of that space sludge conduit means leads to a drain. Normally passage of liquid and contaminant along the conduit means is prevented by closed sludge valve means which is opened to allow passage at the time the piston is or is to be reciprocated.

An outlet for filtrate from the tubular filter element may be at one or a first end thereof. The piston may be normally "parked" in a stationary position at or adjacent the other or second end. Passage means may be provided at the first end of the filter element so that there is communication between regions to either side of the piston thereat, and there may be a by-pass flow of filtrate to the outlet. The aforesaid communication prevents an excessive pressure difference being established across the piston so the latter is not held at the first end of the filter but can carry out its return stroke to the second end. The passage means may comprise grooves in the inner wall of the filter element at the first end.

The sludge valve means may be mechanically connected with the piston such that movement of the piston from the second end of the filter causes the valve means to open. Closure of the valve means may be caused by movement of the piston to or arrival at the second end of the filter element. For example, the tubular element may be substantially vertical in which the piston reprocates substantially vertically. Engaging means may be provided whereby the piston on approaching the end of its return stroke to the second end engages the filter element and lifts the latter. This lifting movement is transmitted from the filter element to the valve means causing closure thereof. At or soon after commencement of a reciprocation by the piston from the second end the filter element may be released from the piston and falls a predetermined distance. This falling movement is transmitted to the valve means causing opening thereof. Mounted on the filter element may be one or more valve members movable relatively to one or more valve seats of said sludge valve means.

The piston may be reciprocated one or more times as and when desired. The reciprocation may be by motor means, for example an electric motor, in response to an electrical control which may also cause automatic opening and closing of the sludge valve means if

the latter is not arranged to be actuated by the filter element.

Or the first mentioned piston may be reciprocated by a fluid actuated second piston and cylinder unit. The actuating fluid may be the filtrate. The pressure of the filtrate within the tubular filter element may be observed or sampled and if below a predetermined value a valve controlled hydraulic circuit operates supplying filtrate to the second piston or cylinder unit causing the first piston to reciprocate in the filter element. The second piston and cylinder unit may be double acting, so that both strokes of the first piston are caused by filtrate pressure. Obviously the second piston and cylinder unit is suitably dimensioned for the force due to the filtrate pressure to reciprocate the first piston.

The filter apparatus may be used to filter bread crumbs from water, but can also be used to filter other contaminant from water or other liquid.

The invention will now be further described by way of example with reference to the accompanying diagramatic drawings in which:

Fig. 1 is a view, partly in section of a filter apparatus formed according to the invention;

Fig. 2 is an enlarged fragment of Fig. 1;

Fig. 3 is a view, similar to Fig. 1, of a modification of the apparatus of Fig. 1, in which a sludge valve arrangement is actuated by movement of the filter element;

Fig. 4 is an enlarged fragment of Fig. 3 showing part of the sludge valve arrangement open;

Fig. 5 is a fragmentary view on a reduced scale on line V-V of Fig. 3, and

Fig. 6 is a modification of the apparatus of Fig. 1 in which the piston is reciprocated by filtrate pressure.

In the drawings like references refer to like parts.

The filter apparatus 2 has a cylindrical casing 4 with a base 6 provided with an outlet conduit 8 for filtrate; the casing having a cover 10 and an inlet conduit 12 for dirty liquid, i.e. the liquid containing contaminant. Within the casing and spaced therefrom by a cylindrical gap 14 is a filter element 16 comprising an open ended, vertical metal cylinder 18 with through radial holes 20 and an external helical winding known per se of thin wire 22 of any desired cross-section. For example, the wire can be wedge-shaped 0.015 inches wide the turns being spaced by 0.015 intervals. A drain conduit 24 leads from the base of chamber 14, this conduit being normally closed by a sludge valve 26 opened and closed by a motor 28.

Within cylinder 18 is a relatively closely fitting piston 30 (shown in full lines in its normally parked position) mounted on a piston rod 32 slidable in liquid tight seals 34 and driven by a motor 36 by which the piston is reciprocated, the bottom of the piston stroke being shown in dotted lines.

To filter dirty liquid it is introduced through inlet 12, the liquid passing into the interior of the filter element 16 and departing therefrom as clean liquid or filtrate through outlet 8 and the contaminant from the liquid being left as debris on the exterior of the filter element 16.

The filter element is cleaned by back-washing the debris off. At the time back-washing is desired, valve 26 is opened allowing some dirty liquid to pass out through drain conduit 24 which cause a reduction in the differential pressure across the wall of the filter element 16, though there is still some liquid flow (allbeit a reduced flow) through the element to outlet 8. This reduced flow is a function of the ratio of the hydraulic resistance of filter element to that of the flow path along the open drain conduit.

At the same or about the same time as the valve 26 is opened, piston 30 is forced down (to the position in dotted lines) by motor 36 causing a pressure surge from inside the filter element 16, and (since the reduced differential pressure creates less external opposition to the pressure surge) the pressure surge in the filtrate causes a primary dislodging of debris from off the exterior of the filter element 16. The piston is then returned to the top of its stroke by the motor 36 and during this stroke filtrate is forced radially outwardly through the filter element 16 and relatively high speed forcing off more debris which is washed away through the drain conduit.

The operation of motors 28 and 36 may be under manual control and the piston 30 reciprocated any desired number of times. Or an automatic control may be provided to carry out the back-washing at predetermined intevals of time, for example every hour for bread crumbs in water, in accordance with the setting of timer means. Or the automatic control may initiate a back-washing cycle upon detection of a pressure drop in the filtrate, (within the tubular interior of the filter element) below a predetermined value resultant from the opposition to fluid flow caused by debris build up on the filter element.

For example, a typical back-washing cycle from water containing bread crumbs would be opening the valve for thirty seconds when washing is desired or demanded and reciprocating piston 30 three, four or five times within that thirty second period.

To prevent pressure within the apparatus holding down the piston in its bottom position or possible locking of the piston thereat due to vacuum in piping connected to the outlet 8, one or more slots 38 extend downwards in the inner face of the cylinder 18 from one or more of the bottom holes 20. The or each slot 38 provides a flow by-pass, passed the piston at the bottom of its stroke, to the outlet.

In the filter apparatus in Figs. 3 to 5 the cylinder 18 can slide vertically being guided

by annulus 40 disposed in an enlarged internal bore of the bottom end of the cylinder, which enlarged bore is terminated at an overhanging annular ledge 42. At its top end the cylinder 18 has an internal overhanging ring 44 fixed axially of the cylinder and engaged by the piston in its "parked" position to hold the filter element in the lifted position shown in Fig. 3.

Adajcent the bottom of the filter element 16 the cylinder 18 has affixed thereto a ring 46 extending across the gap 14 and with an outer edge in sliding contact with the inner wall of the casing 4. From ring 46 depend affixed valve members 48 of a sludge valve arrangement 50. Each valve member comprises a truncated conical part 52 and a cylindrical bottom part 54, and fits a corresponding cylindrically sided aperture 56 in a ring 59 affixed to the wall of casing 94 and extending across the space 14 so the inner edge of ring 59 acts as a bearing for the sliding cylinder 18. The cylindrical part 54 acts as a valve member and is a relatively close sliding fit in its corresponding aperture 56 which is a valve seat. This close fit enables the valve arrangement 50 to have a self-cleaning facility. Through holes 58 in the ring 46 alternate with the mounting of the valve members 52.

When the piston 30 is lowered the filter element 16 falls until ledge 42 engages the top of annulus 40. This falling movement lowers the valve members 54 away from the valve seats 56 (as shown in Fig. 4) thus opening the sludge valve arrangement so that dirty liquid from aperture 58 can pass out through drain 24. When the piston is raised it engages the ring 44 near the end of the upward stroke. This causes the filter element to be lifted to the position in Fig. 3 and the sludge valve arrangement 50 closes automatically by the lifting of the valve members 54 to substantially fully occupy the apertures 56 again (Fig. 3).

In the apparatus in Fig. 6, the piston 30 is reciprocated vertically by another piston 60 on the rod 32. Piston 60 reciprocates in cylinder 62 having a port 64 or 66 at each end, and the piston mounts a spindle 68 with a head 70 to actuate valves 72 and 74 as will be described below.

An hydraulic line 76 communicates with the interior of filter element 16 so that the liquid in line 76 is filtrate at the pressure of the filtrate within the filter element. Line 76 runs to inlet port A of a resiliently biased pressure valve 78 having blanked-off port B and an outlet port C. A bleed-off line 76′ applies filtrate pressure to a valve member against the resilient biasing in valve 78. Outlet port C is connected by line 80 to inlet port D of valve 72 having outlet ports E and F to drain and to line 82 respectively. Line 82 leads to one end of a slide valve member in a valve 84 having inlet ports G and H each connected to branch line 76″ from line 76. Valve 84 has outlet ports I and J to drain and also outlet ports K and L to respective lines 86 and 88 to the ports 64 and 66 respectively. The valve 74 has an inlet port M connected to a branch 76‴ from line 76, a blanked-off port N, an outlet port Q to drain, and an outlet port P to line 90 leading to the other end of the slide valve member in valve 84.

When the piston 30 is fully raised the head 70 holds the valve member in valve 72 in place to connect ports D and F, but when the head lowers with the descending piston 30 resilient biasing switches valve 72 to connect ports E and F. In valve 74 resilient biasing normally holds the valve member thereof in position to connect ports P and Q and to connect ports M and N. But on the head 70 descending to the bottom of its stroke with piston 30, the head moves the valve member of valve 74 against the biasing to connect port M to port P.

The filtrate pressure within filter element 16 drops as the exterior of the element becomes increasingly dirty. The resilient biasing of valve 78 is set so that when the filtrate pressure in the apparatus 2 falls below a predetermined value signifying the need for backwashing (the piston 30 being in the raised position), the pressure on line 76′ drops below that value and valve 78 switches to connect port A to port C. Thus filtrate from line 76 is supplied to line 80 and through connected ports D and F of valve 72 to line 82. The pressure on line 82 ensures the slide in valve 84 connects port G to port K and connects port L to J. Filtrate from line 76″ then passes through valve 84 to line 86 to force piston 60 to descend and lowers the piston 30. At the same time the slide in valve 84 connects ports L and J allowing liquid below piston 60 to leave to drain via line 88 and valve 84.

Once the head 70 moves from valve 72 the valve member in the latter automatically moves to connect ports F and E. Therefore, when descending head 70 actuates valve 74 to connect ports M and N whereby filtrate on line 76‴ is applied via line 90 to shift the slide in valve 84 back, liquid in line 82 can go to drain via valve 72. The shifting back of the slide in valve 84 connects ports H and L and connects ports K and G. Thus filtrate from line 76″ is now supplied on line 88 to the cylinder 62 to lift piston 60 and raise the piston 30. Liquid from above piston 60 can now exhaust to drain via line 86 and valve 84. At the top of the stroke of piston 30, the head 70 again actuates valve 72 to connect port B to port F.

If in the meantime, the filtrate pressure in apparatus 2 has risen above the pre-determined value valve 78 will have been actuated

to connect port A to blanked-off port B and so piston 30 will stop at the top of its stroke. But if the filtrate pressure is still below the predetermined pressure, then piston 30 will be reciprocated again to repeat the back-wash.

CLAIMS

1. A filter apparatus of the type referred to comprising a tube shaped filter element defining a barrel, means for introducing liquid containing suspended contaminant to the exterior of the filter element so that liquid filtrate passes through the filter element into the tube interior leaving filtered-out contaminant on the exterior, and a piston arranged to reciprocate within the barrel so as to force liquid filtrate from the tube interior back thorugh the filter element as back wash during at least one stroke of the piston for the purpose of dislodging filtered-out contaminant from the exterior of the element.

2. Apparatus as claimed in claim 1 wherein the filter element is surrounded by a casing between which and the element is a space into wnich the liquid containing the contaminant is be introduced.

3. Apparatus as claimed in claim 2 wherein the lower part of the casing is associated with sludge discharge conduit through which said filtered out contaminant dislodged from the filter element may be passed, and the sludge discharge conduit is associated with sludge valve means which are openable and closeable to allow said dislodged contaminant to pass through the sludge discharge conduit.

4. Apparatus as claimed in any one of claims 1 to 3 wherein the piston may be parked at said first position and at the second position the filter element has passage means for providing communication between either side of the piston when it is at the second position.

5. Apparatus as claimed in claim 4 wherein the passage means comprise grooves in the inner wall of the filter element.

6. Apparatus as claimed in claim 3 wherein the sludge valve means are mechanically connected with the piston such that movement of the piston from the second position to the first position causes the sludge valve means to open.

7. Apparatus as claimed in claim 6 wherein the filter element is vertical, a seat is provided on which the filter element seats when the piston is in the second position, engagement means are provided on the filter element for engagement by the piston as it approaches its first position so as to raise the filter element from its seat, and said sludge valve means are closed by raising the filter element from its seat.

8. Apparatus as claimed in claim 7 wherein the sludge valve means comprise at least one valve plug mounted on the filter element for movement therewith and at least one corresponding aperture forming a vlave seat for the plug provided in a barrier element between the sludge discharge conduit and the filtrate inlet.

9. Apparatus as claimed in claim 8 wherein in addition to the aperture or apertures providing valve seats, the barrier element has at least one additional through aperture.

10. Apparatus as claimed in claim 8 or 9 wherein the barrier element is annular and provides a bearing for the filter element.

11. Apparatus as claimed in any one of claims 1 to 10 wherein the piston is reciprocated by a fluid actuated second piston and cylinder unit.

12. Apparatus as claimed in claim 11 comprising first valve means adapted to supply filtrate from the apparatus alternately along two fluid flow pathways to one side or the other of the second piston thereby to effect reciprocating movement of the first piston, said first valve being switchable by fluid pressure signals to provide for said supply of filtrate alternately along said two fluid flow pathways.

13. Apparatus as claimed in claim 12 comprising second and third valve means which are in communication with filtrate and which, dependent on the position of the second piston, supply filtrate as a pressure signals to effect switching of said first valve means.

14. Apparatus as claimed in claim 13 wherein actuation of the second piston is initiated by a fluid pressure signal from fourth means which are switched to supply filtrate to the first valve means via the second valve means upon a decrease in filtrate output pressure below a predetermined valve.

15. A filter apparatus of the type referred to substantially as hereinbefore described with reference to Figs. 1 to 2, or Figs. 3 to 5, or Fig. 6 of the accompanying drawings.

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